

July 1, 2021

BY ELECTRONIC FILING

Marlene H. Dortch
Secretary
Federal Communications Commission
45 L Street, N.E.
Washington, DC 20554

Re: *SpaceX Semi-Annual Report*

Dear Ms. Dortch:

Pursuant to paragraph 97u of the modification order issued on April 27, 2021,¹ Space Exploration Holdings, LLC provides the attached semi-annual constellation status report covering the period from December 1, 2020 to May 31, 2021.

If you have any questions, please do not hesitate to direct them to me.

Sincerely,

/s/ *David Goldman*

David Goldman
Director of Satellite Policy

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Attachment

cc: Karl Kensinger

¹ See *Space Exploration Holdings, LLC*, FCC 21-48, ¶ 97u (rel. Apr. 27, 2021).

SPACEX CONSTELLATION STATUS REPORT
December 1, 2020 - May 31, 2021

SpaceX appreciates this opportunity to update the Commission and the public about the reliability and safety of its satellite constellation. As this report details, SpaceX's satellites have very high post-mission disposal reliability, and their performance has only continued to improve to near 100% reliability. To ensure safe operations, SpaceX uses extremely conservative assumptions that minimize risk and exceed industry standards and approaches by a large margin. For example, SpaceX uses a maneuver threshold a full order of magnitude more sensitive than the industry standard, resulting in SpaceX satellites making maneuvers significantly more frequently than they would have using the industry standard and mitigating each encounter to very low risk levels. The vast majority of these maneuvers were to avoid non-maneuverable satellites or debris, rather than other operational satellites. Taking this more conservative approach requires SpaceX to make a significant investment in more capable satellites and it results in more maneuvers that also carry considerable cost to SpaceX. But SpaceX takes this conservative approach out of an abundance of caution to best preserve and protect low Earth orbit.

SpaceX volunteered to report on the health of its system because it believes transparency is critical to sustainable space operations. Indeed, this report is just one of a number of steps SpaceX is taking to improve transparency. For instance, SpaceX provides all of its tracking data to space-track.org including covariance for all operators and has gone even further to make this data available publicly to anyone with a space-track.org account. SpaceX has also worked closely with academics, industry experts, commercial SSA providers, and government agencies like the 18th Space Squadron to improve the quality of data provided.

In addition, SpaceX reached a Space Act Agreement with NASA and its Conjunction Assessment and Risk Analysis (CARA) program. Consistent with that agreement, NASA and CARA have agreed in principle to conduct a formal evaluation of all or a representative set of the "events" involving SpaceX satellites in the past six months, all of which have been described in this report, as well as the efficacy of SpaceX's autonomous collision avoidance system during those events in which a SpaceX maneuver was required. SpaceX strongly encourages all operators—including those that chose to license outside the U.S.—to have trusted third parties review their operations.

SpaceX makes these efforts to improve transparency because knowledge about where objects are and better predictions about where they are going to be are critical to sustaining the orbital environment. Improving location and predictive information for these objects in concert with our efficient, robust, and responsive propulsion system that supports both station-keeping and Collision Avoidance Maneuvers (CAMs) will help drive the likelihood of future collisions to near zero.

Yet SpaceX cannot maintain a sustainable orbital environment unilaterally; no operator, and indeed no country, can. SpaceX therefore pleads once again for other operators—again, including those that have chosen to license their satellites outside the U.S. and claim not to be bound by U.S. rules—to provide similar public disclosures about the performance of their

satellites. Only with all operators working together can we truly maintain the space environment for future operations and human space flight.

RESPONSES TO COMMISSION REQUESTS

1. *“Number of conjunction events identified for Starlink satellites during the reporting period, and the number of events that resulted in an action (maneuver or coordination with another operator), as well as any difficulties encountered in connection with the collision avoidance process and any measures taken to address those difficulties.”*

Events/Maneuvers—SpaceX uses a conservative maneuver threshold an order of magnitude more sensitive than the industry standard. Specifically, SpaceX satellites will maneuver if the probability of collision is greater than $1e-5$ (1 in 100,000 chance of collision), as opposed to the industry standard of $1e-4$ (1 in 10,000 chance of collision). Using this standard, SpaceX satellites performed 2,219 maneuvers over the period of this report.

For other events, other operators asked SpaceX not to perform a maneuver because the operators preferred to maneuver their satellites; this circumstance occurred about five times over this period.

Other Issues—“difficulties encountered in the collision avoidance process and the steps taken to resolve those difficulties.”

- *Reducing burden on the 18th SpaceX Squadron.* SpaceX is always working to reduce the burden on the 18th Space Squadron without compromising safety. For instance, SpaceX reduced the number of launch times required for pre-launch screening from every second to every 10 seconds. This reduces the workload of the 18th for pre-launch screening by a factor of 10 with only small operational impacts that have no effect on space sustainability.
- *Transparency.* In the interest of openness for the general public, SpaceX has made all of its predictions of future satellite locations available to anyone with a space-track account. SpaceX is the first company to make this detailed information available through space-track and SpaceX strongly encourages operators to publish the same information about their satellites.
- *More responsive collision-avoidance screening.* While the SpaceX constellation orbit design facilitates nominal passive trajectory deconfliction, SpaceX has implemented a second layer of security by means of a dedicated internal SpaceX-on-SpaceX conjunction screening. This process runs an order of magnitude faster than the standard screening process against debris and enables SpaceX satellites to stay aware of the latest states of all other SpaceX satellites in their vicinity.

2. *“Satellites that, for purposes of disposal, were removed from operation or screened from further deployment at any time following initial deployment, and identifying whether this occurred less than five years after the satellite began regular operations or were available for use as an on-orbit replacement satellite.”*

Satellite Number	Can the satellite still maneuver for collision avoidance?	Removed <5 years after beginning operation?
STARLINK-1025	Yes	Yes
STARLINK-1044	Yes	Yes
STARLINK-1051	Yes	Yes
STARLINK-1075	Yes	Yes
STARLINK-1078	Yes	Yes
STARLINK-1081	Yes	Yes
STARLINK-1095	Yes	Yes
STARLINK-1127	Yes	Yes
STARLINK-1155	Yes, with attitude control only	Yes
STARLINK-1164	Yes	Yes
STARLINK-1198	Yes	Yes
STARLINK-1214	Yes	Yes
STARLINK-1592	Yes	Yes
STARLINK-1632	Yes	Yes
STARLINK-1652	Yes	Yes
STARLINK-1685	Yes	Yes
STARLINK-1691	Yes	Yes
STARLINK-1731	Yes	Yes
STARLINK-1744	Yes	Yes
STARLINK-1745	Yes	Yes
STARLINK-1778	Yes	Yes

STARLINK-1779	Yes	Yes
STARLINK-1796	Yes	Yes
STARLINK-1847	Yes, with attitude control only	Yes
STARLINK-1855	Yes	Yes
STARLINK-1881	No	Yes
STARLINK-1897	Yes	Yes
STARLINK-1935	Yes	Yes
STARLINK-1937	Yes	Yes
STARLINK-1949	Yes	Yes

3. *“Satellites that re-entered the atmosphere.”*

Satellite Number	Date of Re-entry	Re-entered <5 years after beginning operation?
STARLINK-1158	2020-12-05	Yes
STARLINK-60	2020-12-26	Yes
STARLINK-1772	2020-12-27	Yes
STARLINK-1447	2021-01-08	Yes
STARLINK-1702	2021-03-06	Yes
STARLINK-55	2021-03-09	Yes
STARLINK-1175	2021-03-19	Yes
STARLINK-75	2021-03-28	Yes
STARLINK-26	2021-04-10	Yes
STARLINK-1900	2021-04-17	Yes
STARLINK-48	2021-04-18	Yes
STARLINK-1045	2021-04-23	Yes
STARLINK-1841	2021-05-28	Yes

4. “Satellites for which there was a disposal failure, including a discussion of any assessed cause of the failure and remedial actions.”

<i>Satellite Number</i>	<i>Cause</i>	<i>Remedial Action</i>	<i>Is SpaceX in contact with the satellite and does it have attitude control for collision avoidance?</i>
STARLINK-1155	Propulsion failure	Design out component that failed, software update to reduce component on-time	Yes
STARLINK-1847	Propulsion failure	Tighter controls on seal gland machining	Yes
STARLINK-1939	Solar array failure	Design change to increase solar array backsheet thickness	No